Computing Division R&D Capabilities

- In addition to its more visible operational roles the Computing Division has always had a role in the development of new techniques in the DAQ and computing end of HEP experiments. Accelerator physics has recently been included.
- These have tended to be focused efforts and therefore not always so visible.
- I've polled my colleagues for recent examples and current interests. This report is intended to be representative, not exhaustive.

- Contacts and acknowledgements:

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Detector & Accelerator Simulation

CD supports and develops detector and accelerator modeling software. In most cases development is driven by specific user needs and the implementation is done in collaboration with the users.

A couple of "success" stories from the last 5 years:

- Fast MC developed to model BTeV; work done with members of the collaboration http://cepa.fnal.gov/CPD/mcfast/
- CMS test beam & calorimeter prototype modeling (G4 based tools)
- G4 based ionization cooling modeling tools, to support muon collider and neutrino factory R&D. Applications (http://cepa.fnal.gov/CPD/geant4/) in collaboration with external users,& FNAL BD
- Development of accelerator modeling tools for collective beam effects. Used to model existing machines, put prime candidate to use in next generation accelerator modeling, in collaboration with users. Also, the development of the parallel algorithms and beam physics models is done in collaboration with beams physicists and computer scientists
  http://cepa.fnal.gov/psm/aas/Advanced_Accelerator_Simulation.html

Data Acquisition

One current collaborative project is:

- the RTES ITR grant. collaboration with the BTeV trigger group and computer scientists in developing fault tolerant easily evolvable, large scale real time clusters
  http://www-btev.fnal.gov/public/hep/detector/rtes/index.shtml

Other present possibilities

- Virtual control rooms. Minos and BTeV will most likely run only remotely, but US/CMS has a strong desire to run the experiment from multiple locations.
- Capitalizing on spare CPU cycles of large scale online farms for offline activities.
- replacing tape archival systems with other media types, in particular disk

Electronics Systems

Recent collaborative projects

- CDF DAQ system
  - Many Modules (GSTM, DEM, SRC, VRB, VTM, VFO, FIB, FTM, FFO, CPC and other assorted TLAs)
- PIXEL detectors (CDF and BTeV)
- D0 DAQ system.
  - Central Fiber Tracker Mixer system
  - VRB system
  - "Alpha" and subsequent "Beta" Trigger Processor modules
  - Timing Distribution System
  - Detector luminosity monitor firmware

Electronics Systems

Resources

- appropriate hardware tools, including
  - logic analyzers, oscilloscopes, power supplies, pulse generators, function generators,
  - microelectronics lab equipment, probe stations
  - optoelectronics lab equipment
- sited at, and staffed by ESS

  - Wire Bonding equipment,
  - Hot/Cold Oven,
  - X-Ray inspection system,
  - Ball Grid Array tooling,
- appropriate software/firmware tools
  - simulation software
    - FPGA/BGA programming tools- one BGA chip for SNAP project costs over $4,000
- experienced with state-of-the-art exotic materials
  - Beryllium-Oxide Port Cards for CDF
  - multi-layer Flex Cable assemblies

Farms, Networks, Storage

- We continue to do work on ethernet and commodity networks to do event building and interface to commodity computing.

- The Lattice QCD project deals with commecial high performance networks, wich are thought of from time-to-time for DAQ roles. There is experience wiht Myrinet, and interest (along with evaluation experience and substantial chance of deployment) of Infiniband .

- The central storage systems are a disk cache-fronting tape. They have performant grid (GRidFTP, FTP, and Storage Resource Manager) interfaces. FNAL currently has over 1 petabyte of data stored in these systems, moves over 10 terabytes of data to and from tape in these systems, and moves more than 20 terabytes of data though these "dCache" systems each day in production. The systems are used by CMS and Minos as components of a wide area network based systems. Fermilab continues active developments of features in these systems.

Core Support Services

- Evaluation, acquisition and integration of large clusters of commodity pc's (production & analysis farms), including tools and techniques for managing and operating large clusters of similar systems (installation, monitoring, etc.).
- Performance evaluation of network-attached storage systems (this work in collaboration with CMS, for e.g.).
- Design, development and support of on- and off-line production databases for the experiments, including reliability and performance tuning.
- Layout and specialized fabrication, test and calibration of physics electronics (in collaboration with ESE). We have specialized facilities for ball-grid array and wire-bonding work, and x-ray inspection.